L. L. NARAYANA* & K. T. SUNDARI*:
Embryology of the Pittosporaceae (1)

L. L. ナラヤナ*・K. T. スンダリ*: トベラ科の胚発生 (1)

The Pittosporaceae has not received much attention from the point of view of embryology. Davis (1966) reviewed the works of Tieghem (1884), Bremer (1915), Schürhoff (1929) and Mauritzon (1939). Subsequently, Sheela & Narayana (1966) reported some observations on the embryology of this family. The present paper deals with the embryology of *Hymenosporum flavum* (Hook.) FvM. and *Marianthus procumbens* Benth.

Materials and methods The material was fixed in formalin-aceto-alcohol. Usual methods of dehydration, infiltration and embedding were followed. The sections cut at a thickness of 7-12 microns were stained using crystal violet and erythrosin combination.

Microsporogenesis and male gametophyte The primary archesporium differentiated at the time when the anther primordium becomes 4-lobed, consists of 3-4 rows of hypodermal cells (Fig. 1). The archesporial cells divide periclinally producing the primary parietal layer along the outside and primary sporogenous layer towards the inside. The cells of the primary parietal layer by repeated periclinal, followed by anticlinal divisions give rise to four wall layers below the epidermis (Fig. 2). The hypodermal wall layer develops characteristic banded thickenings and functions as the endothecium (Fig. 18). The innermost layer functions as the tapetum of the glandular type. The intervening middle layers become crushed during the development of the anther. The cells of the tapetum are uni-nucleate to start with. As the microsporocytes begin to undergo meiosis, the tapetal cells enlarge and become 2-4 nucleate and show vacuolate cytoplasm (Figs. 3-6). Nuclear divisions are followed by nuclear fusions and the polyploid tapetal nuclei show varying number of nucleoli (Figs. 7-9). The tapetum is completely absorbed by the time the pollen grains attain maturity.

The cells of the primary sporogenous layer undergo a few more divisions

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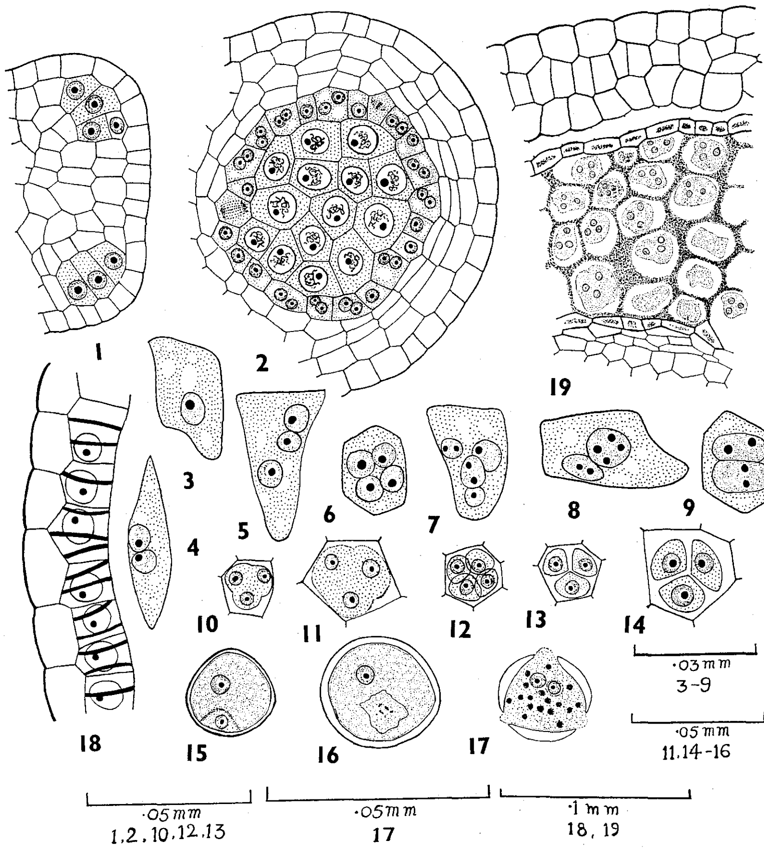


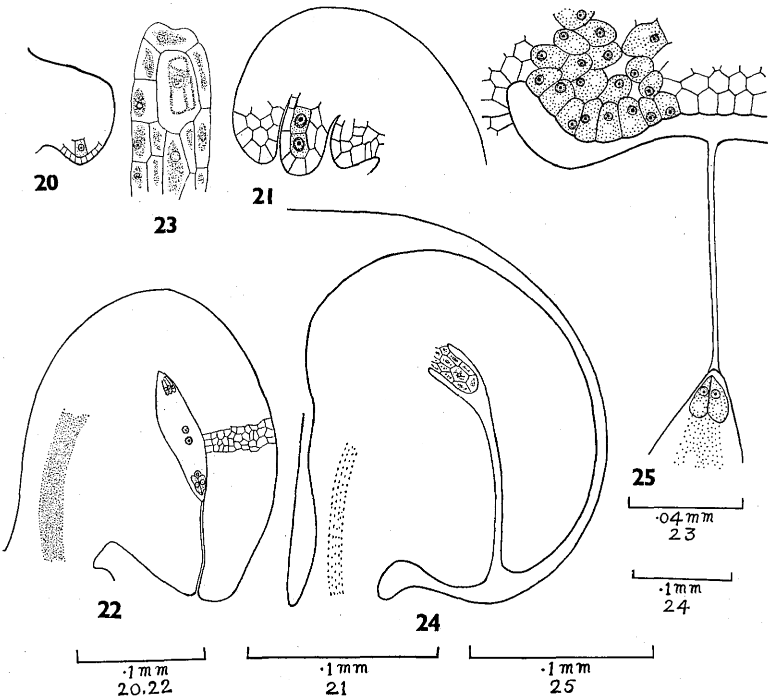
Figs. 1-19. Embryology of Pittosporaceae. Figs. 1, 2, 10, 12, 13, 17. *Marianthus procumbens*; Figs. 3-9, 11, 14-16, 18, 19. *Hymenosporum flavum*. 1. Transverse section of anther showing archesporium. 2. Transverse section of anther lobe showing wall layers, tapetum and microspore mother cells. 3-9. Tapetal cells showing multinucleate condition and nuclear fusion. 10, 11. Pollen mother cells showing cytokinesis. 12-14. Pollen tetrads. 15. Young pollen grain showing vegetative and lenticular generative cell. 16, 17. Mature pollen grains. 18. Endothecium. 19. Transverse section of a part of anther lobe showing degenerative microspore mother cells.

and function as microsporocytes. As a result of meiosis four microspore nuclei are formed. Cytokinesis takes place by furrowing (Figs. 10, 11). Pollen tetrads show tetrahedral arrangement (Figs. 13, 14). Decussate tetrads were observed in *Marianthus procumbens* (Fig. 12). The pollen grains are 3-

colporate and are 2-celled at the time of shedding (Figs. 15-17).

In *Hymenosporum flavum* degeneration of anthers was observed in some flowers (Fig. 19). The development proceeds normally up to the differentiation of the anther and the microsporocytes enter meiosis. But subsequent devolopment becomes arrested. The tapetal cells shrink and the cytoplasm becomes deeply stained. The protoplasts of the microsporocytes also shrink and ultimately degenerate. Their walls become mucilaginous and deeply stained. In such anthers no microspores were produced.

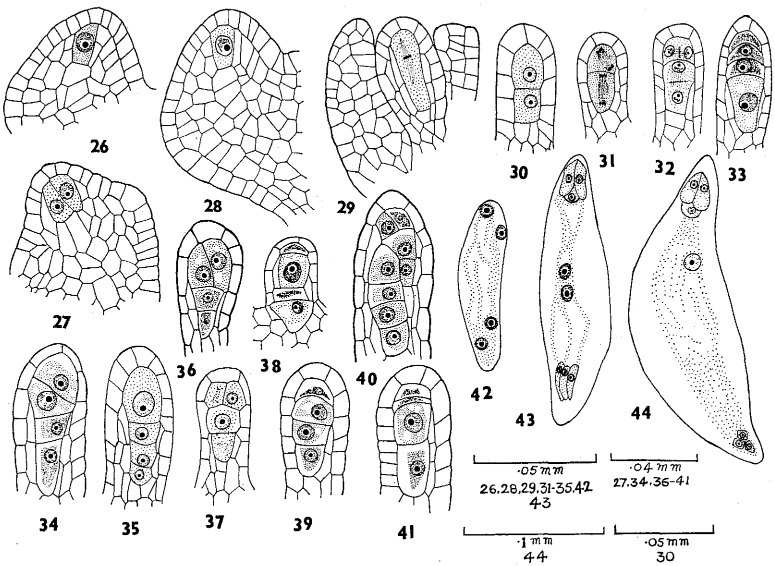
Megasporangium The ovule is tenuinucellate, unitegmic and ana-campylotropous. The ovule primordium arises as a projection on the placenta (Fig. 20). During development it undergoes curvature and the mature ovule



Figs. 20-25. Embryology of the Pittosporaceae. Figs. 20-22, *Marianthus procumbens*: Figs. 23-25, *Hymenosporum flavum*. 20-22. Stages in development of the ovule. 23. Longitudinal section of nucellus showing degeneration of cells. 24. Longitudinal section of ovule showing arrested development of nucellus and well developed integument. 25. Longitudinal section of ovule showing obturator like cells.

becomes ana-campylotropous (Figs. 21, 22). The ovules are horizontally placed and best median sections are obtained in transverse sections of ovaries. The integument on the antiraphe side is 8-10 layered in *Marianthus procumbens* and 10-12 layered in *Hymenosporum flavum*. The micropyle is long. There is no differentiation of endothelium. In *Hymenosporum flavum* the cells lining the ovary wall adjacent to the funiculus are conspicuous by their larger size and dense contents and may serve as an obturator (Fig. 25).

Some ovules show arrested development in *Hymenosporum flavum*. The development proceeds normally up to the megasporocyte stage or tetrad stage (Figs. 23, 24). Further development is arrested but the integument grows as in the normal ovules. As a result a space is enclosed above the arrested nucellus and this looks like an "embryo sac".



Figs. 26-44. Embryology of the Pittosporaceae. Figs. 28, 29, 31-33, 38, 42, 43. *Marianthus procumbens*; Figs. 26, 27, 30, 34-37, 39-41, 44. *Hymenosporum flavum*. 26. Primary archesporium. 27. Multicellular archesporium. 28. Megaspore mother cell stage. 29. Megaspore mother cell in division. 30. Dyad stage. 31, 32. Dyad cells in division. 33-35, 38, 39, 41. Linear megaspore tetrads. 36, 37. 'T' shaped tetrads. 40. Juxtaposed double tetrads. 42. 4-nucleate stage of embryo sac. 43. Organized embryo sac. 44. Mature embryo sac.

Megasporogenesis and female gametophyte The archesporium is hypodermal and single celled (Fig. 26). Although a multicellular archesporium is frequently met with (Fig. 27), only one becomes functional. The archesporial cell directly functions as the megasporocyte without cutting off a primary parietal cell (Fig. 28). Meiosis in the megasporocyte results in the formation of a tetrad of megaspores which show linear or a 'T' shaped arrangement (Figs. 29, 32). Normally the chalazal megaspore is functional and the other three megaspores degenerate (Fig. 33). Enlargement of one or more megaspores has been noticed in both the taxa. These enlarging megaspores look like functional megaspores with prominent nuclei and deeply staining cytoplasm (Figs. 34, 39 and 41). Fig. 40 shows juxtaposed double tetrads of which one is linear and the other T-shaped.

The functional megaspore enlarges and undergoes three successive free nuclear divisions (Fig. 42) to give rise to an 8-nucleate embryo sac (Fig. 43). The mature embryo sac shows the usual organization (Fig. 44). The egg apparatus consists of two synergids and an egg. The polar nuclei fuse before fertilization (Fig. 44). The antipodals are organized as distinct cells. The embryo sac during growth enlarges and crushes the cells of the integument along the sides.

Discussion The primary archesporium is plate like and 3-4 cell wide as also reported by Sheela & Narayana (1966) in *Pittosporum floribundum*, *Hymenosporum flavum*, *Marianthus procumbens* and *Bursaria spinosa*. The tapetum is of the secretory type and the cells become multinucleate while according to Sheela & Narayana (1966) the tapetal cells in *Hymenosporum flavum* are binucleate. Cytokinesis takes place by furrowing. Both 2- and 3-celled condition of pollen occurs in the family.

The ovule is tenuinucellar and unitegminal. Mauritzon (1939) described the ovules in the family as amphi-anatropous while Davis (1966) described them as anatropous. The present study shows that they are ana-campylotropous. Although a multicellular archesporium has been observed only one of the cells is functional. However, occasionally more than one cell may become functional and result in twin megaspore tetrads. Frequent occurrence of 'T' shaped tetrads and enlargement of one or more megaspores of the tetrad other than the chalazal are noteworthy features in the taxa under the present study. The development of embryo sac conforms to the polygonum

type. Absence of endothelium in a tenuinucellate, unitegmic ovule is noteworthy.

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トベラ科の2種 *Marianthus procumbens* と *Hymenosporum flavum* の胚発生が研究された。それらの胚囊形成の様式はタデ型 (Polygonum type) であった。

○高等植物分布資料 Materials for the distribution of vascular plants in Japan

94 ヤマラッキョウ *Allium Thunbergii* G. Don (New to the Bonin Is.) これまで小笠原諸島ではネギ属植物の自生は記録されていなかった。古瀬義氏は1974年11月5日に父島，初寝山の岩崖で一種を発見し，困難を冒して花のある2株とごく少数の生品を採集された (古瀬 No. 7434, 東大)。標本では葉が軟かい感じで幅 3 mm 内外，花序には8花ほどがばらっとついていた。しかし生品を参考にして鱗茎，葉，花波，雄蕊などの諸形質を検討したところ，ヤマラッキョウの一品という結論になった。ヤマラッキョウは分布も広く変異が著るしく，小笠原産と同じ形は九州にも見られる。小笠原にヤマラッキョウが人為的に持ちこまれたとは考え難いので自生と見てよいであろう。小笠原諸島にまた本州要素の一例を加えたことになる。貴重な資料の研究を委ねられた古瀬氏に深謝する。 (原 寛 Hiroshi Hara)